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(54) Electrical contact

(57) An electrical contact is designed with a plurality of spiraling legs such that when compressed, the spiral legs create a rotation of the top of the contact resulting in a wiping action to the contacting device or pad. The resulting micro-spider contact may be used for a wide variety of non-permanent or permanent electrical connection purposes including use in construction of an interposer.

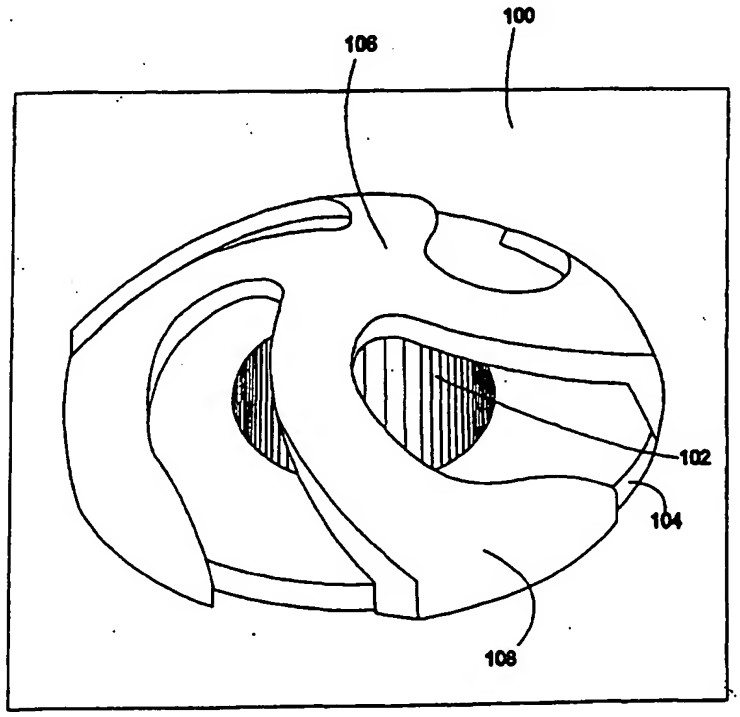

FIG. 1

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Description

[0001] This invention relates generally to an electrical contact and more specifically to an electrical contact incorporating a wiping action.

[0002] In designing electrical devices, modular structures are often used to allow non-permanent attachment of modules. This allows for upgrading or repairing of devices without requiring expensive reworking of the circuit board. Non-permanent attachment of modules also allows field replacement of defective or out-of-date modules. Reusable non-permanent electrical contacts require the ability to make reliable electrical contacts with a module over repeated connection and disconnection of the contacts. The contacts also are required to withstand a large number of connection and disconnection cycles without sustaining damage. Also, as electrical designs shrink in size there is pressure to design reliable contacts as small as possible.

[0003] One specific type of electrical contact is an interposer. Interposers are placed between two electrical devices. One of the devices may be a circuit such as a multi-chip module (MCM) and the other may be a printed circuit board. As electrical devices shrink in size, interposers must also allow for increased contact densities while still allowing repeated, reliable electrical contacts. Existing electrical contact designs include interposers constructed from elastomeric material and interposers constructed from balls of wire. Both of these solutions have limitations inherent in their design. Current elastomeric materials are unable to sustain adequate contact spring force over time and temperature and have a small range of working heights. Interposers constructed from balls of wire are fragile, often prone to unravel, require costly inspection, and provide a limited amount of contact travel.

[0004] An electrical contact is designed with a plurality of spiraling legs such that when compressed, the spiral legs create a rotation of the top of the contact resulting in a wiping action to the contacting device or pad. The resulting micro-spider contact may be used for a wide variety of non-permanent or permanent electrical connection purposes including use in construction of an interposer.

[0005] Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example a number of preferred embodiments of the invention.

Figure 1 is a perspective view of an embodiment of a micro-spider contact according to the present invention.

Figure 2A is a top view of an embodiment of a clockwise micro-spider contact according to the present invention.

Figure 2B is a top view of an embodiment of a counter-clockwise micro-spider contact according to the present invention.

Figure 3 is an oblique view of a plurality of micro-spider contacts according to an embodiment of the present invention.

Figure 4 is a cross-sectional view of an embodiment of the present invention illustrating micro-spiders constructed on opposite sides of a substrate.

Figure 5A is a cross-sectional view of an embodiment of the present invention illustrating a single pair of micro-spider contacts.

Figure 5B is a cross-sectional view of an embodiment of the present invention illustrating a single pair of micro-spider contacts.

Figure 6 is an oblique view of an embodiment of the present invention illustrating a single clockwise micro-spider and a single micro stop.

Figure 7 is a cross-sectional view of an embodiment of the present invention illustrating a single pair of micro-spiders and a single pair of micro stops.

Figure 8 is a perspective view of an embodiment of a three-legged counter-clockwise micro-spider according to the present invention.

Figure 9 is a perspective view of an embodiment of an array of three-legged counter-clockwise micro-spiders according to the present invention.

Figure 10 is a cross-sectional view of an embodiment of the present invention illustrating micro-spiders constructed on a first side of a substrate and ball grid array (BGA) balls constructed on a second side of a substrate.

[0006] Figure 1 is a perspective view of an embodiment of a specialized electrical contact created pursuant to the present invention referred herein to as a micro-spider contact, or simply as a micro-spider. In Figure 1 the micro-spider 106, is an example embodiment of the present invention with four spiraling legs 108 attached to an area of metal 104 surrounding a through-plated hole 102 in a substrate 100 material. The micro-spider 106 is preferably constructed from a thin sheet of metal, and may be fabricated by a variety of methods. One method for constructing micro-spiders is described further in a U.S. patent application, Serial No. 09/917,357 "Method for the Fabrication of Electrical Contacts", filed concurrently with the priority document of the present application, and incorporated herein by reference. Another method for the fabrication of micro-spiders is described in a U.S. patent application, Serial No. 09/917,093 "Method for the Fabrication of Electrical Contacts", filed concurrently with the priority document of the present application, and incorporated herein by reference. Note that other embodiments of the present invention may include micro-spiders with 3 legs **108**, or 5 or more spiraling legs **108**. In the example embodiment of the present invention shown in Figure 1 the legs **108** of the micro-spider **106** spiral in a clockwise direction. Note that micro-spiders **106** may be constructed with legs **108** spiraling in either a clockwise or counter-

clockwise direction within the scope of the present invention. In fact, in certain applications of the concepts of the present invention it may be desirable to include both clockwise and counter-clockwise micro-spiders **106** in the same device. By mixing the two types of micro-spiders in an approximately equal amount and approximately equal distribution, the slight rotational torque applied as each micro-spider **106** contact is compressed is approximately equalized between the clockwise and counter clockwise direction, resulting in a very small net rotational torque.

[0007] Figure 2A is a top view of an embodiment of a clockwise micro-spider contact according to the present invention. The micro-spider **106** shown in Figure 2A is identical to the device of Figure 1 as seen from the top. Again, micro-spider **106**, preferably includes four spiraling legs **108** attached to an area of metal **104** surrounding a through-plated hole **102** in a substrate **100** material. Figure 2B is a top view of an embodiment of a counter-clockwise micro-spider contact according to the present invention. The micro-spider 106 shown in Figure 2B is similar to the device of Figure 2A except with counter-clockwise spiraling legs **108** instead of the clockwise spiraling legs **108** shown in Figure 2A.

[0008] Figure 3 is a perspective view of a plurality of micro-spider contacts according to an embodiment of the present invention. The example illustrates an array of micro-spiders **106** on a substrate **100**. In this embodiment, all of the micro-spiders **106** shown are clockwise micro-spiders **106**. In other embodiments of the present invention, counter-clockwise micro-spiders **106** may be used, or a combination of clockwise and counter-clockwise micro-spiders **106** may be used.

[0009] In a specific example embodiment of the present invention, micro-spiders **106** are preferably constructed on both sides of the substrate **100** creating an interposer for use in non-permanently attaching electronic devices such as a multi-chip module (MCM) to a circuit board. Figure 4 is a cross-sectional view of such an embodiment. The example embodiment of the present invention shown in Figure 4 illustrates a plurality of micro-spiders **106** constructed on opposite sides of a substrate **100**, connected together by through-plated holes **102** surrounded by areas of metal **104** contacting the legs **108** of the micro-spiders **106**. This example embodiment of the present invention may be employed as an interposer for use in non-permanently attaching electronic devices such as a MCM to a circuit board.

[0010] Figure 5A is a cross-sectional view of an embodiment of the present invention illustrating a single pair of micro-spider contacts. The device of Figure 5A illustrates a counter-clockwise micro-spider **106** similar to the device shown in Figure 2B on the top surface of the substrate **100**, and a clockwise micro-spider **106** similar to the device shown in Figure 2A on the bottom surface of the substrate **100**. The two micro-spiders **106** are preferably electrically connected to each other by a through-plated hole **102** in the substrate **100** where each hole **102** is surrounded by an area of metal **104** electrically and mechanically contacting the legs **108** of the micro-spiders **106**.

[0011] Figure 5B is a cross-sectional view of another embodiment of the present invention illustrating a single pair of micro-spider contacts. The device of Figure 5B illustrates a clockwise micro-spider **106** similar to the device shown in Figure 2A on the top surface of the substrate **100**, and a counter-clockwise micro-spider **106** similar to the device shown in Figure 2B on the bottom surface of the substrate **100**. The two micro-spiders **106** are preferably electrically connected to each other by a through-plated hole **102** in the substrate **100** where each hole **102** is surrounded by an area of metal **104** electrically and mechanically contacting the legs **108** of the micro-spiders **106**.

[0012] In some example embodiment of the present invention, it may be preferable to add a micro stop to prevent over-compression of the micro-spiders when connecting to a device such as a printed circuit board (PCB) or MCM. Figure 6 is a perspective view of an embodiment of a single clockwise micro-spider and a single micro stop according to the present invention. The addition of a micro stop **600** to a device comprising at least one micro-spider **106** allows the connection of, say, a MCM to the device without over-compressing the legs **108** of the micro-spiders **106**. The micro stop preferably halts further compression of the micro-spiders **106** when the devices are a pre-determined distance apart, as set by the height of the micro stop **600**. The example embodiment of the present invention of Figure 6 shows a clockwise micro-spider **106** electrically connected to the metal **104** surrounding a through-plated hole **102** in a substrate **100**.

[0013] Figure 7 is a cross-sectional view of an embodiment of a single pair of micro-spiders **106** and a single pair of micro stops **600** according to the present invention. A clockwise micro-spider **106** similar to that described in connection with Figure 2A is shown on the top surface of the substrate **100**, and a counter-clockwise micro-spider 106 similar to that described in connection with Figure 2B is shown on the bottom surface of the substrate **100**. The two micro-spiders **106** are electrically connected to each other by a through-plated hole **102** in the substrate **100** where each hole **102** is surrounded by an area of metal **104** electrically and mechanically contacting the legs **108** of the micro-spiders **106**. The two micro stops **600** may be constructed by a variety of methods within the scope of the present invention. The height of the micro stops **600** is determined by the structure and materials used in creating the micro-spiders **106**. The micro stops **600** are preferably short enough to allow enough compression of the micro-spiders **106** such that the spiraling legs **108** cause the top of the micro-spiders **106** to rotate slightly creating a wiping action on the device with which they are brought into contact. This wiping action may physically remove oxides or other contaminants from the device the micro-spiders **106**

are contacting, thereby creating a more reliable electrical contact than would be obtained by a similar contact without any wiping action. The micro stops **600** are preferably tall enough to prevent the contacting device from over-compressing the legs **108** of the micro-spiders **106**. If the legs **108** are over-compressed, they may deform or break. If the legs **108** deform, their useful life as a re-usable contact may be shortened because they may not be able to create the wiping action, and they may become brittle due to strain hardening and may eventually break.

[0014] Micro-spiders may be made with a variety of numbers of legs **108**. Note that any number of legs greater than one may be used in creating a micro-spider **106** within the scope of the present invention. Figure 8 is a perspective view of an embodiment of a three-legged counter-clockwise micro-spider according to the present invention. It will be appreciated that a three-legged micro-spider **800** allows a different amount of wiping action and spring force than an equivalent four-legged micro-spider **106** previously described in connection with Figures 1 through 7. This three-legged micro-spider **800** embodiment of the present invention comprises spiraling legs **108** attached to an area of metal **104** surrounding a through-plated hole **102** in a substrate **100** material.

[0015] Figure 9 is a perspective view of an embodiment of an array of three-legged counter-clockwise micro-spiders according to the present invention. In this example embodiment, all of the micro-spiders **800** shown are counter-clockwise three-legged micro-spiders **800** on a substrate **100**. In other embodiments of the present invention, clockwise three-legged micro-spiders **800** may be used, or a combination of clockwise and counter-clockwise three-legged micro-spiders **800** may be used. In further embodiments of the present invention, three-legged micro-spiders **800** may be constructed on both sides of the substrate **100** creating an interposer for use in non-permanently or permanently attaching electronic devices such as a multi-chip module (MCM) to a circuit board.

[0016] In a specific example embodiment of the present invention, micro-spiders **106** are preferably constructed on a first side of the substrate **100** and ball grid array balls **1000** are preferably constructed on a second side of the substrate **100**, creating an interposer for use in non-permanently attaching electronic devices such as a multi-chip module (MCM) to a circuit board. Figure 10 is a cross-sectional view of such an embodiment. The example embodiment of the present invention shown in Figure 10 illustrates a plurality of micro-spiders **106** constructed on a first side of a substrate **100**, and ball grid array (BGA) balls **1000** constructed on a second side of a substrate **100**, connected together by through-plated holes **102** surrounded by areas of metal **104** contacting the micro-spiders **106**. This example embodiment of the present invention may be employed as an interposer for use in non-permanently attaching electronic devices such as a MCM to a circuit board, while the interposer is attached to the circuit board by the BGA balls **1000**.

Claims

1. An electrical contact **106** comprising:

   spiraling legs **108** configured to create a wiping action on a metal pad when compressed by said pad.

2. An electrical contact **106** as claimed in claim 1, wherein said spiraling legs **108** form a dome shape.

3. An electrical contact **106** as claimed in claim 1 or 2, further comprising:

   a micro stop **600** of sufficient height to prevent over-compression of said spiraling legs **108** of said electrical contact **106**.

4. An electrical contact **106** as claimed in any preceding claim, wherein said electrical contact **106** comprises at least 2 legs **108**.

5. An electrical contact **106** as claimed in any preceding claim, wherein said electrical contact **106** is constructed from copper.

6. An interposer comprising:

   at least two electrical contacts **106** one on each opposing sides of a substrate **100**; wherein said electrical contacts **106** include spriraling legs **108** configured to create a wiping action on metal pads when compressed by said pads.

7. An interposer as claimed in claim 6, wherein said spiraling legs **108** form a dome shape.

8. An interposer as claimed in claim 6 or 7, further comprising:

   at least one micro stop **600** of sufficient height to prevent over-compression of said spiraling legs **108** of said electrical contacts **106**.

9. An interposer as claimed in any of claims 6 to 8, wherein said electrical contacts **106** are disposed opposite each other on opposing sides of said substrate **100** and are electrically connected by through-plated holes **102** in said substrate **100**.

10. An interposer comprising:

    a plurality of electrical contacts **106** on a first side of a substrate **100**; wherein said electrical

contacts **106** include spiraling legs **108** configured to create a wiping action on metal pads when compressed by said pads, and
a plurality of ball grid array balls **1000** on a second side of said substrate **100**.

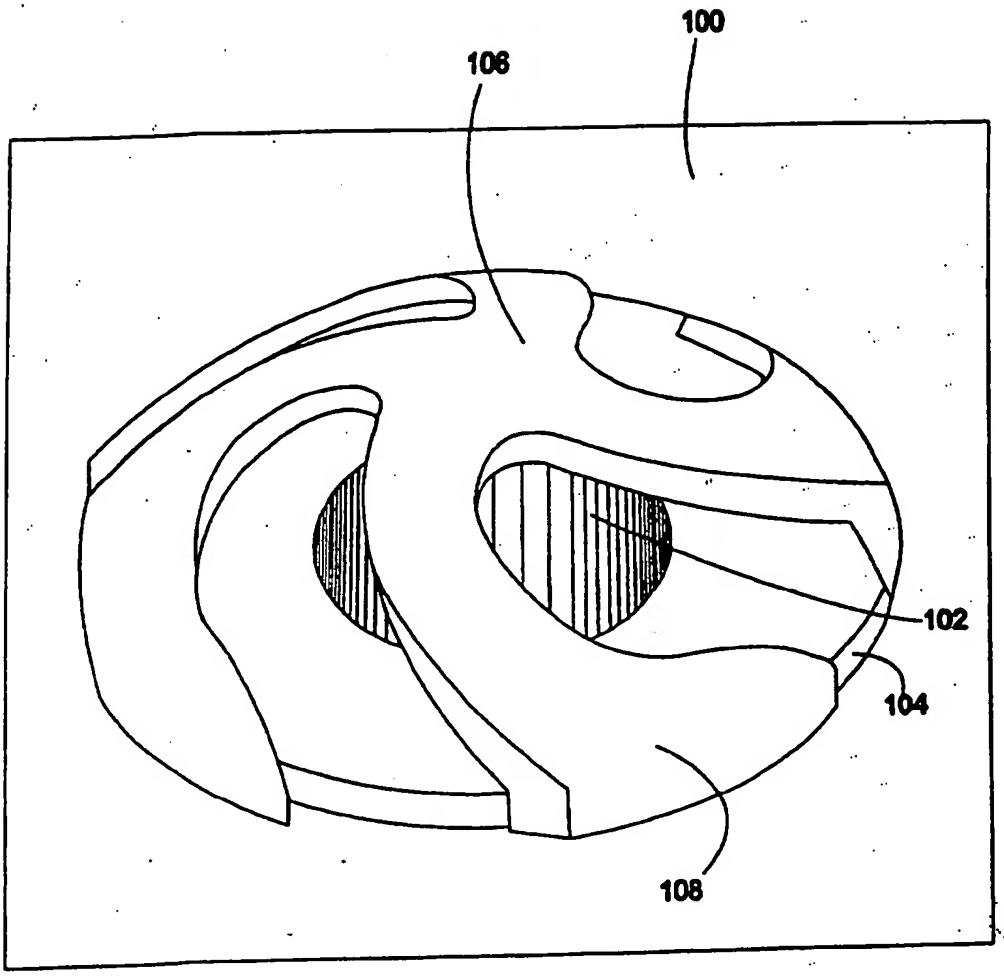

FIG. 1

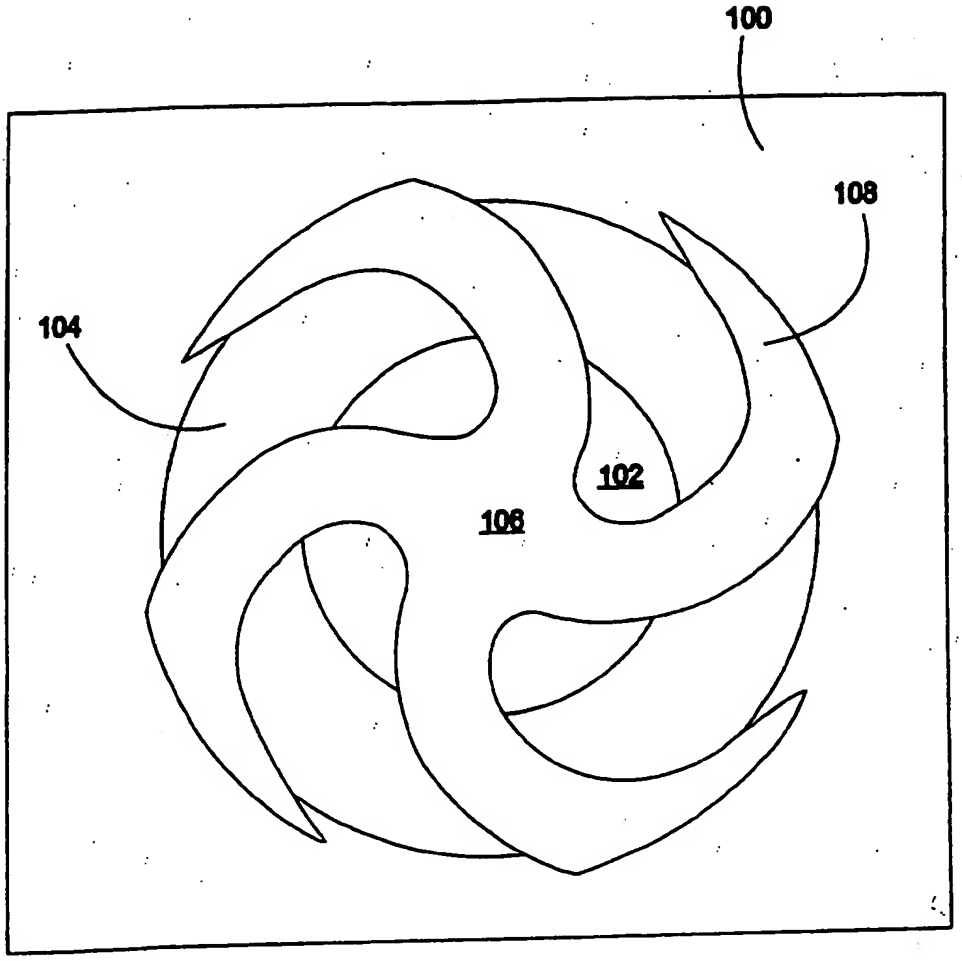

FIG. 2A

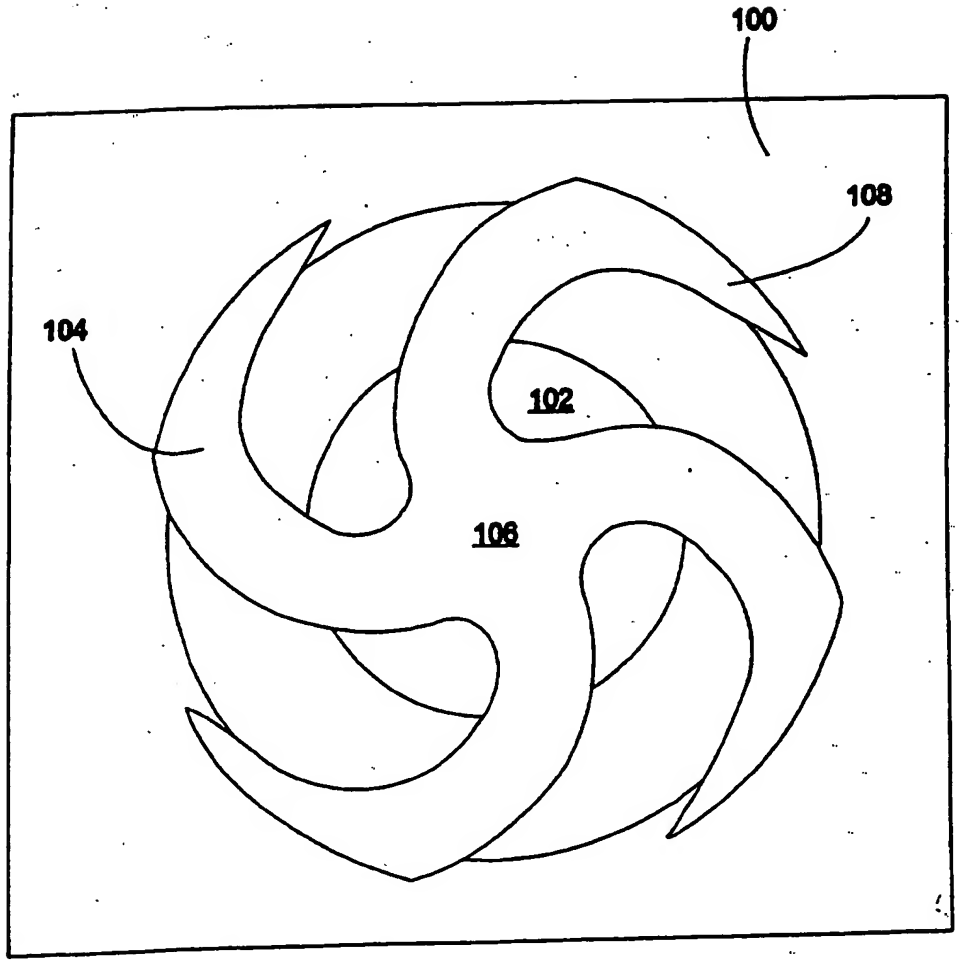

FIG. 2B

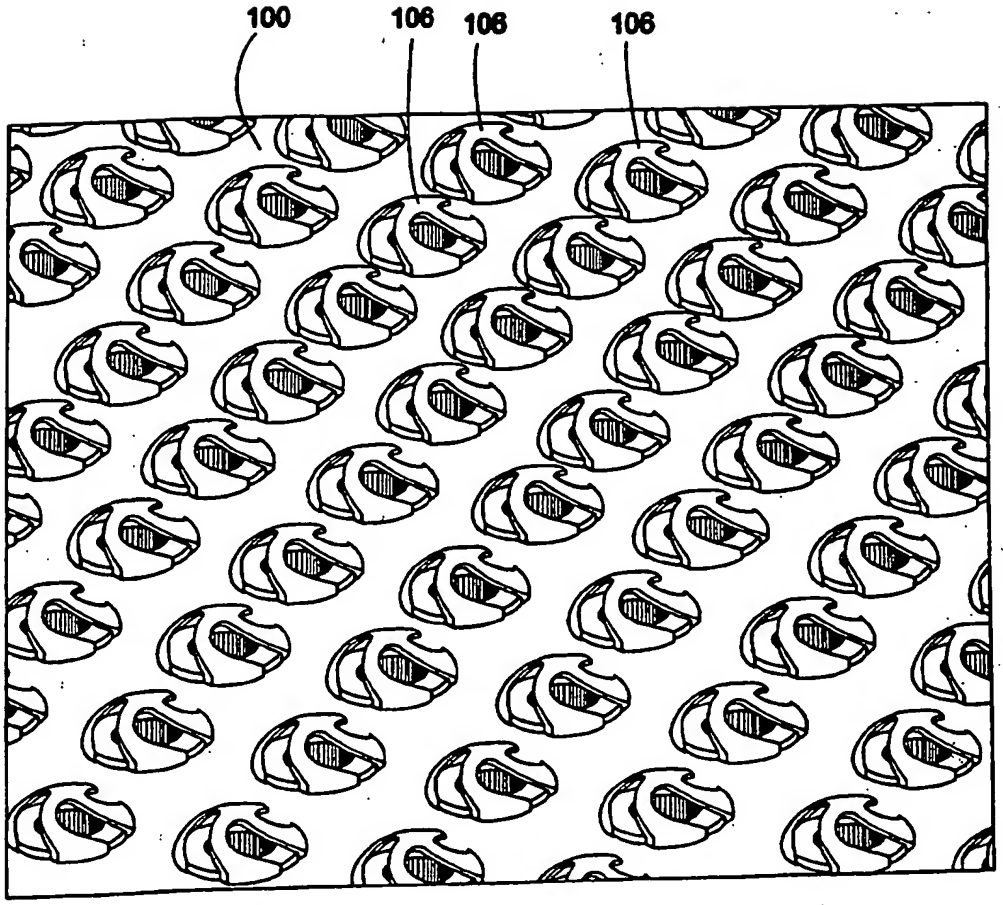

FIG. 3

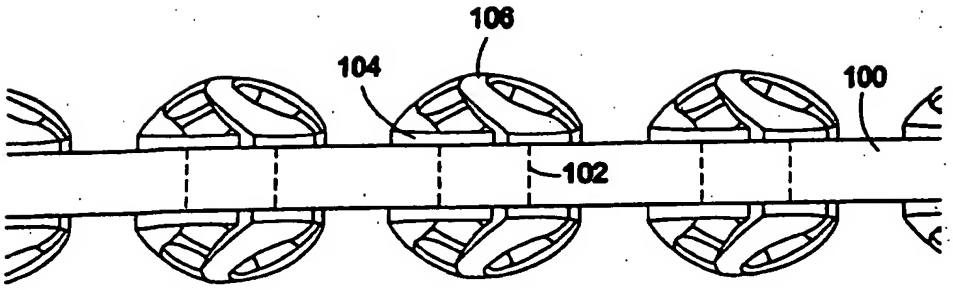

FIG. 4

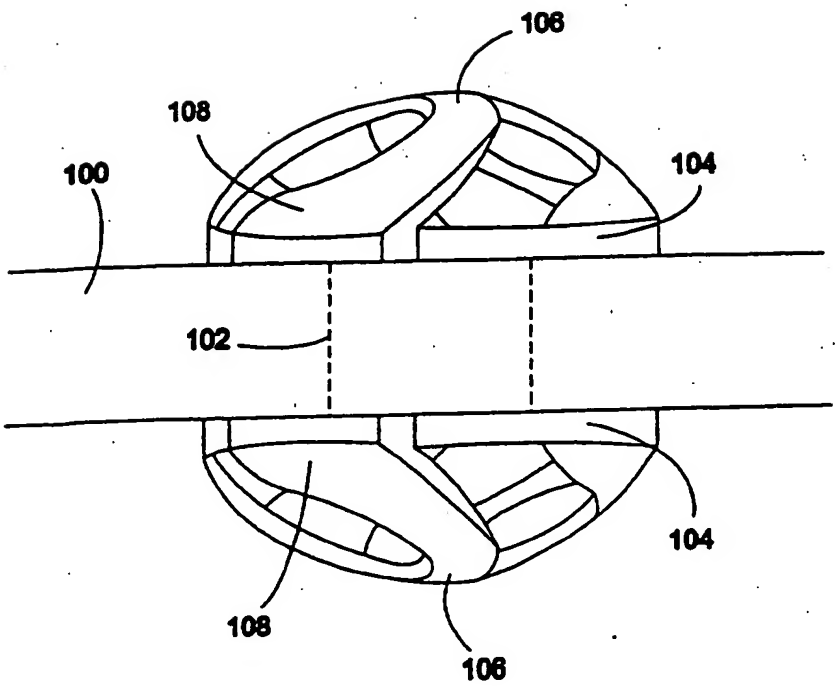

FIG. 5A

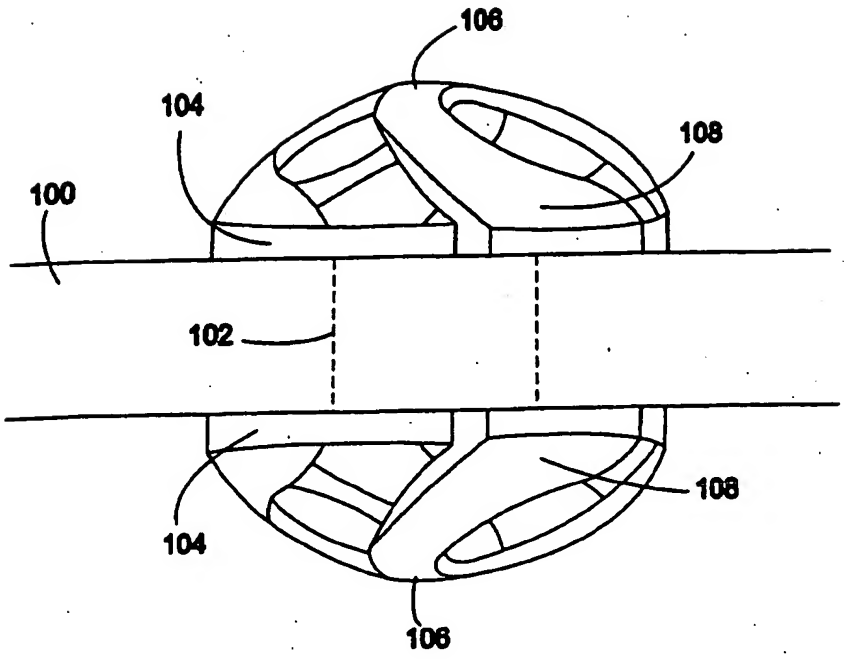

FIG. 5B

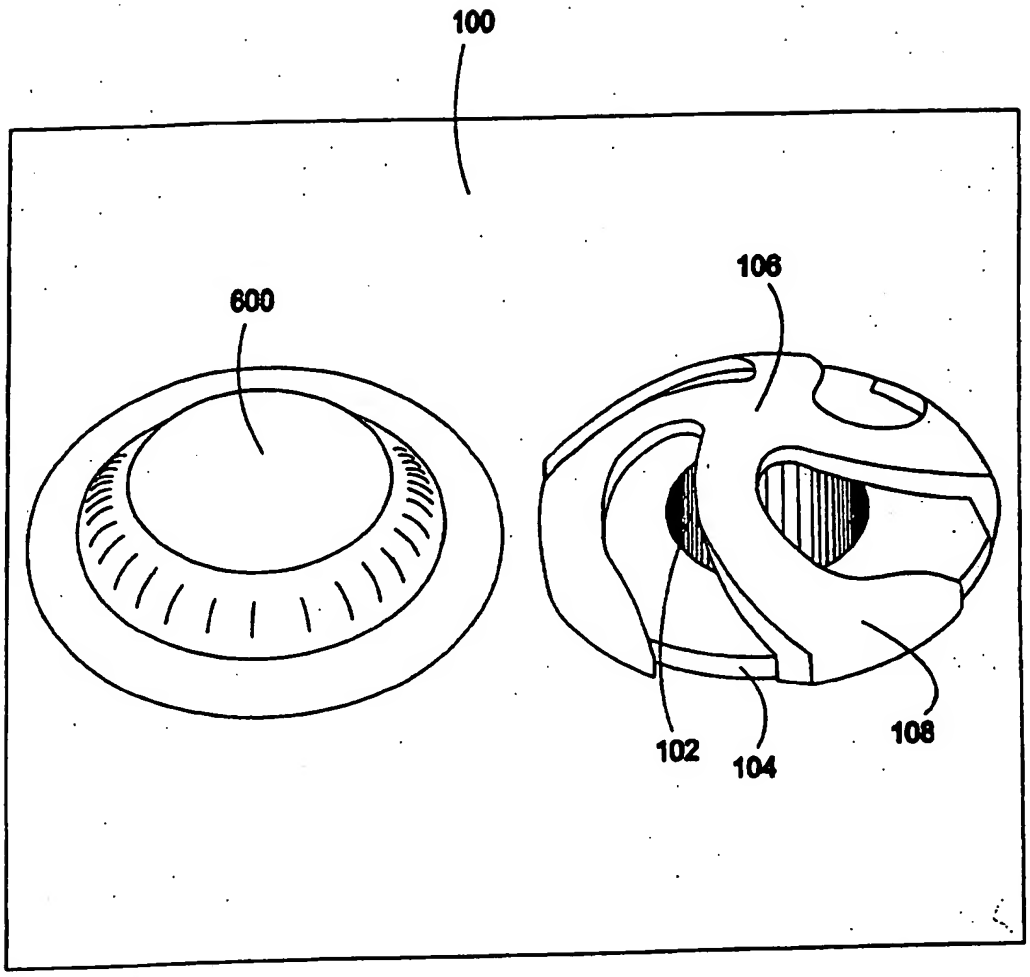

FIG. 6

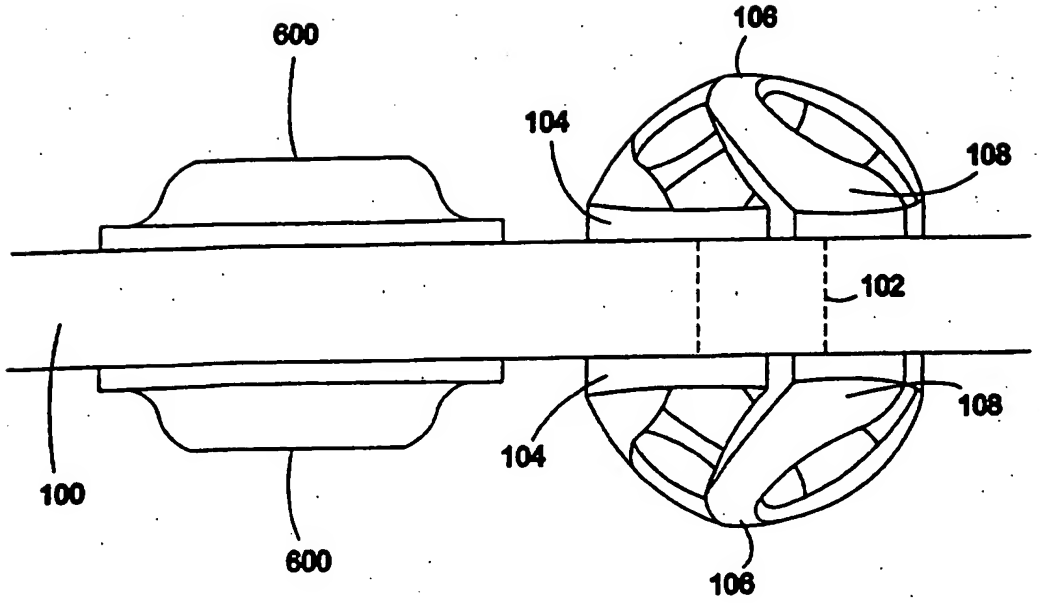

FIG. 7

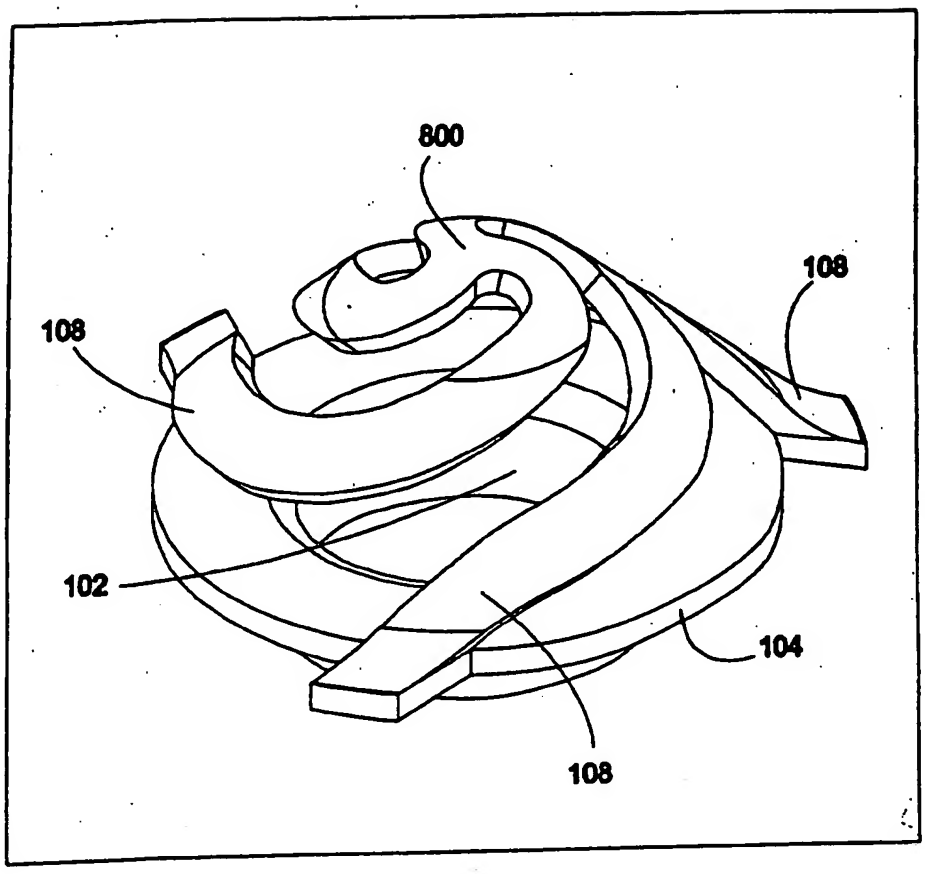

FIG. 8

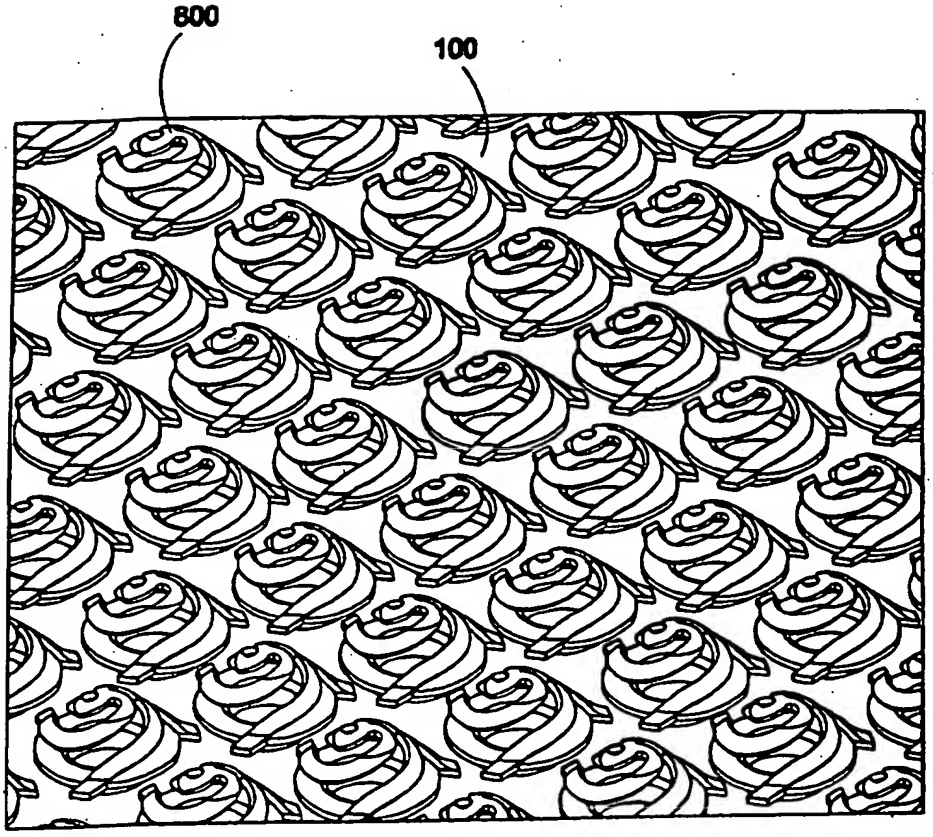

FIG. 9

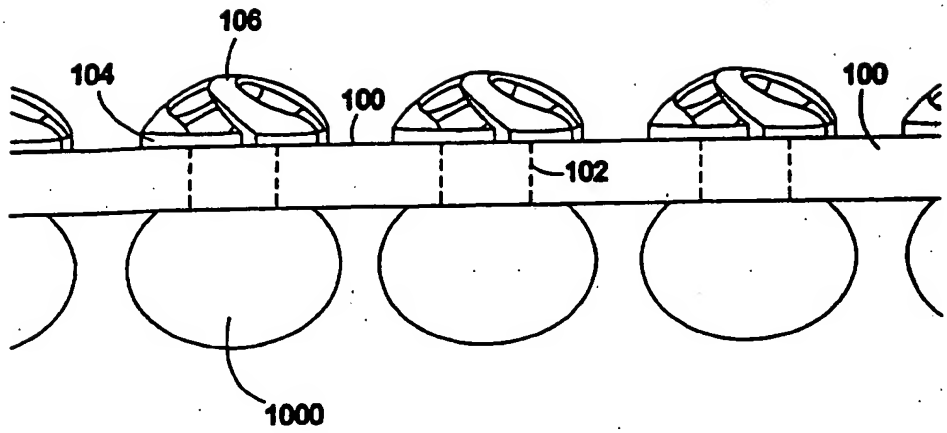

FIG. 10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 02 25 5280

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 1 049 205 A (BERG ELECTRONICS MFG) 2 November 2000 (2000-11-02)	1-8,10	H01R13/24 H01R12/22
Y	* column 1, line 48 - column 2, line 6 * * column 3, line 52 - column 4, line 6 * * column 4, line 25 - column 4, line 50 * * column 5, line 3 - column 5, line 16 * * column 5, line 42 - column 6, line 7; figures 1-5B *	9	H01R12/04
Y	US 5 071 359 A (ARNIO BARBARA E ET AL) 10 December 1991 (1991-12-10) * column 3, line 18 - column 3, line 40 * * column 3, line 56 - column 4, line 1; figures 1-3A *	9	
A	US 5 366 380 A (REYMOND WELLES K) 22 November 1994 (1994-11-22) * figures 3A-9 *	1,2,4,6,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01R
H05K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	26 November 2002	Ledoux, S

CATEGORY OF CITED DOCUMENTS

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